Idaho National Engineering and Environmental Laboratory

Nuclear Fuel Cycle Closure

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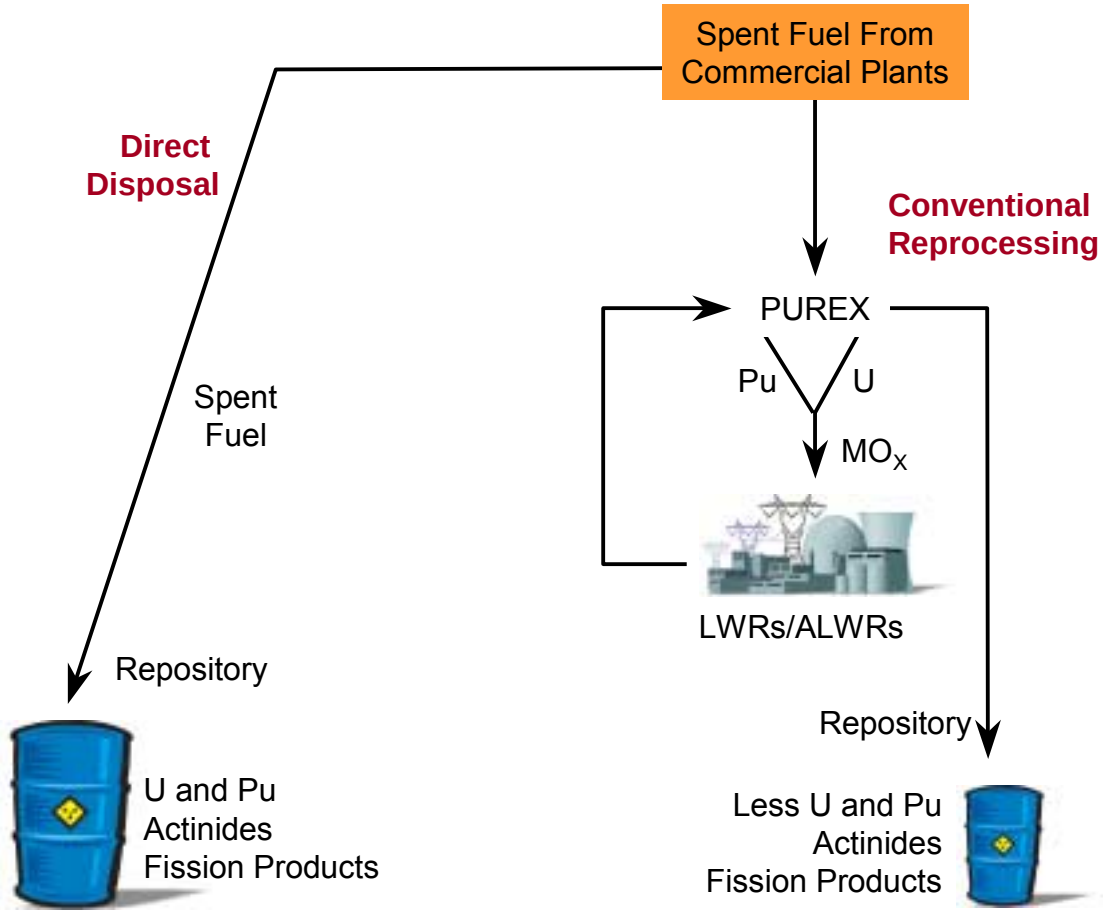
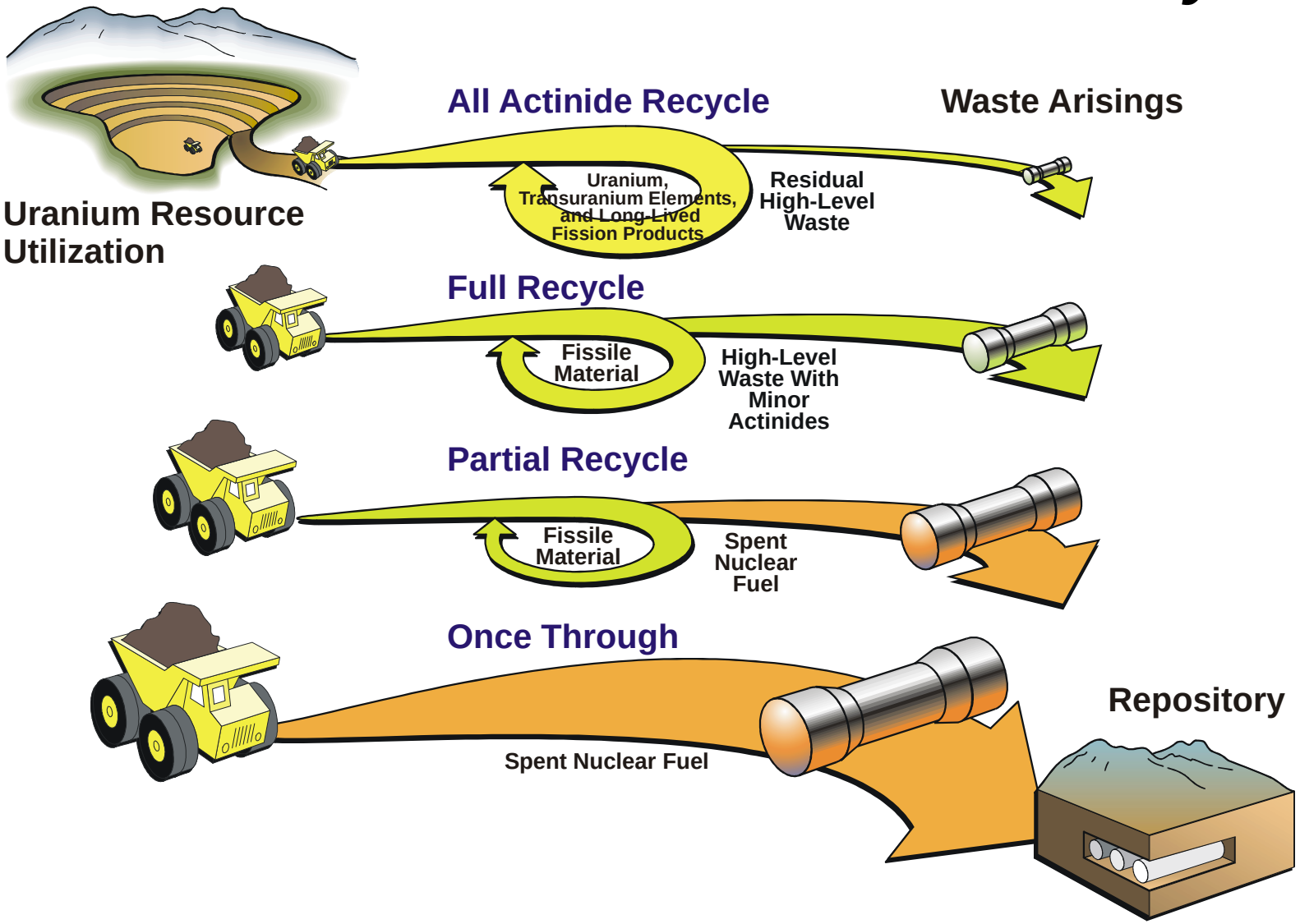
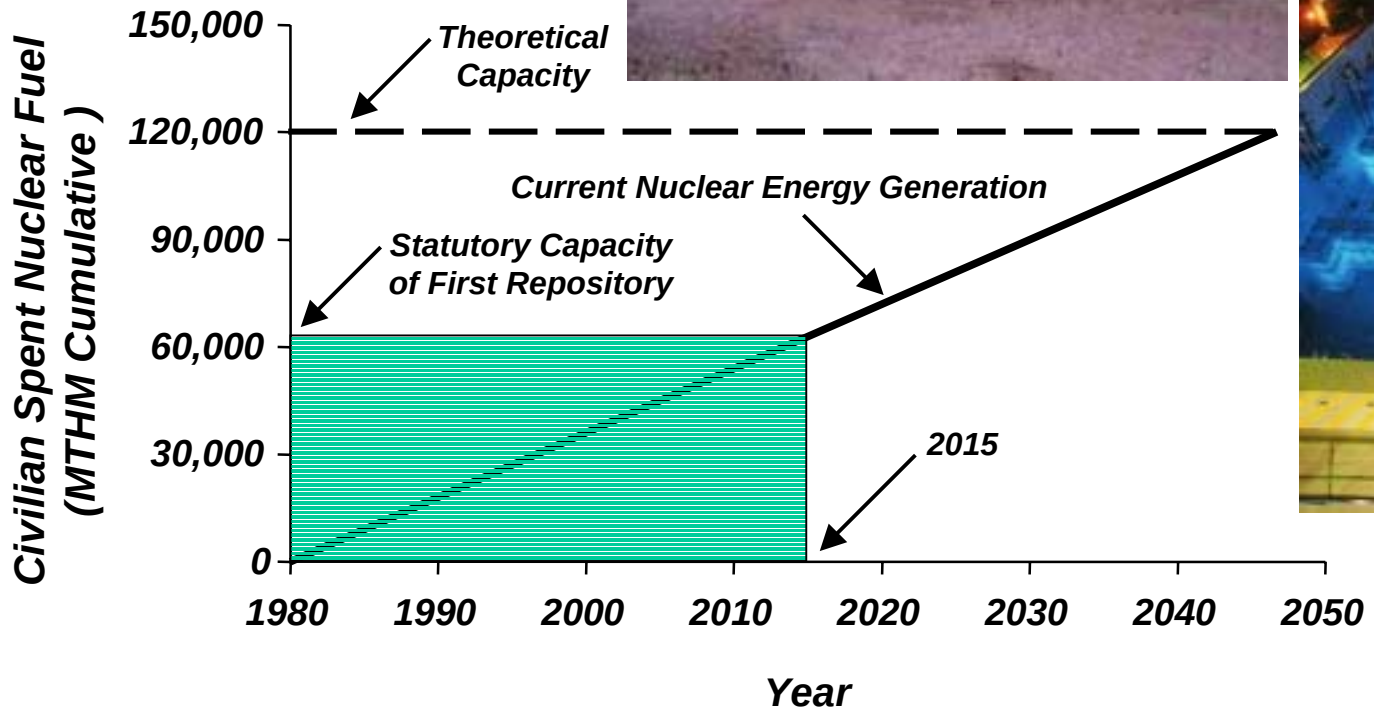
Current World Fuel Cycles



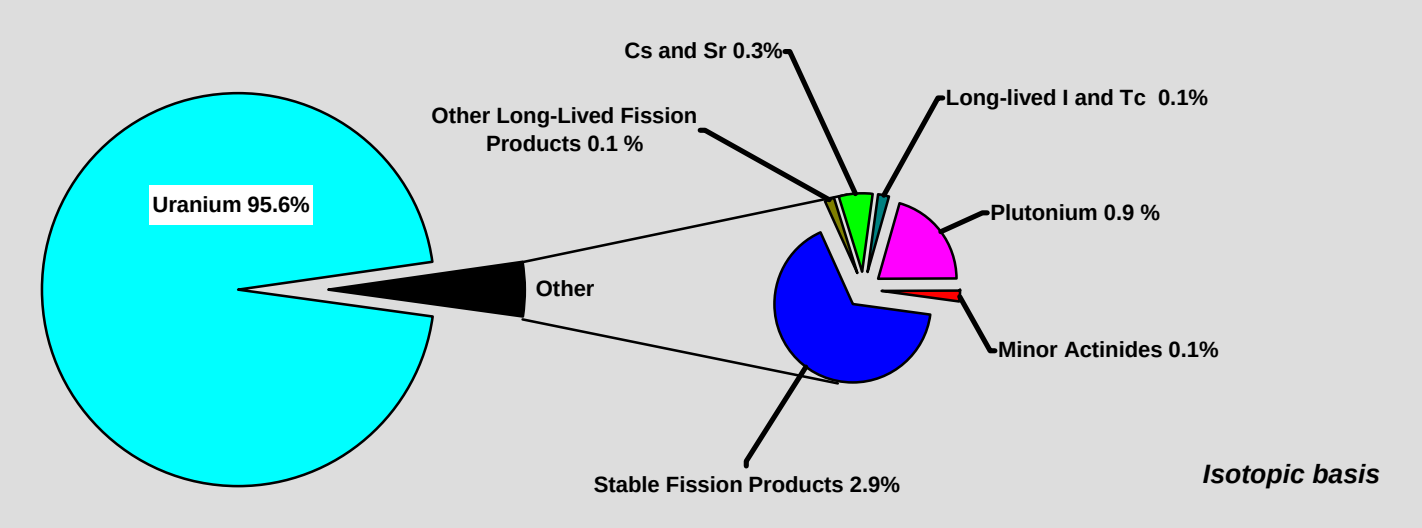
Four General Classes of Nuclear Fuel Cycle



Spent Nuclear Fuel (SNF) from the Once-Thru Fuel Cycle in the U.S.



Constituents of Spent Nuclear Fuel



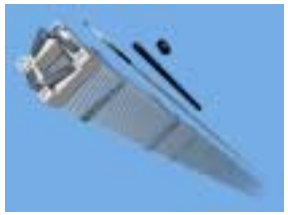
Partitioning makes sense:

- ***Most is U and Pu, which can be usefully recycled***
- ***Most heat production is in Cs and Sr, which decay in 300 yr***
- ***Most radiotoxicity is in long-lived fission products and the minor actinides, which can be transmuted and/or disposed in much smaller packages***

Closing the Nuclear Fuel Cycle



Mining/Milling → Conversion → Enrichment




Fuel Fabrication → Nuclear Power Plant

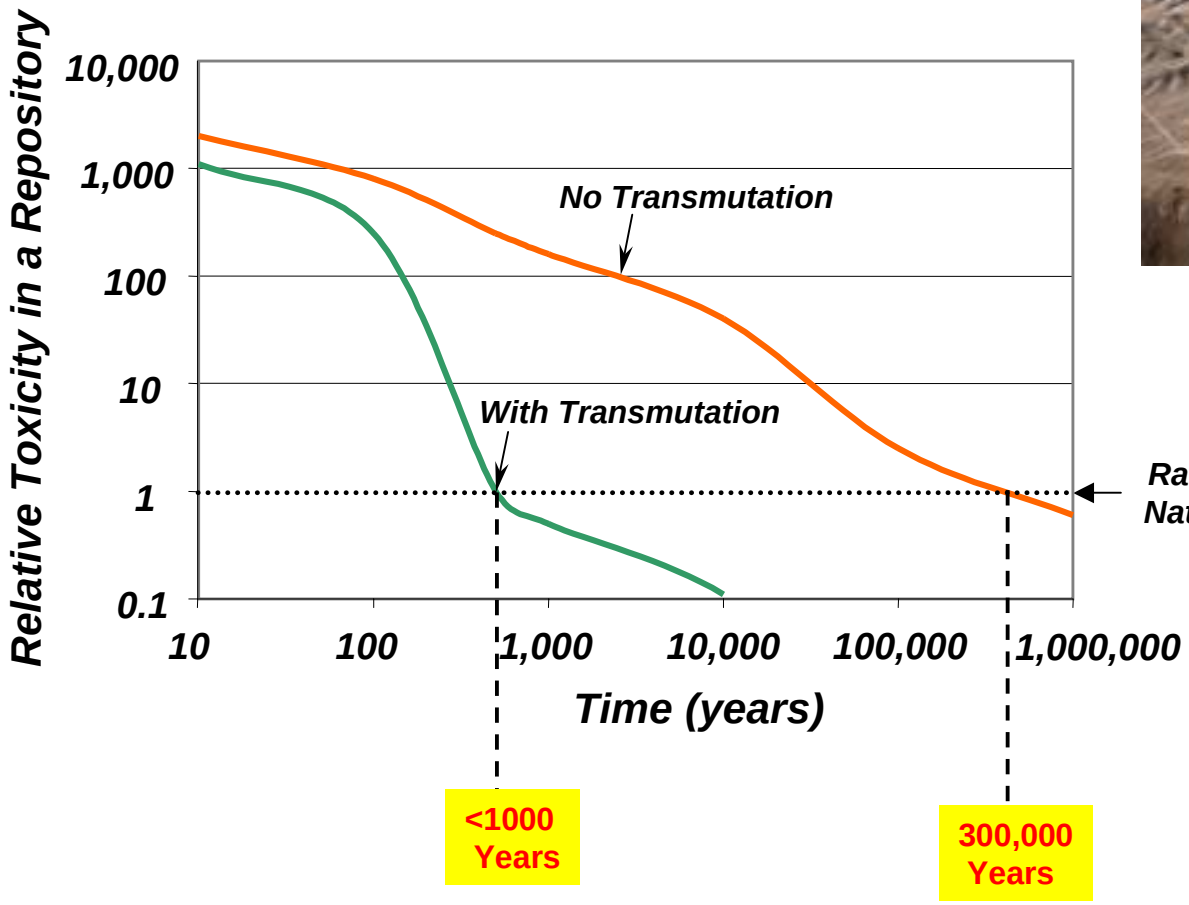
Reprocessing

SNF Transportation

Repository

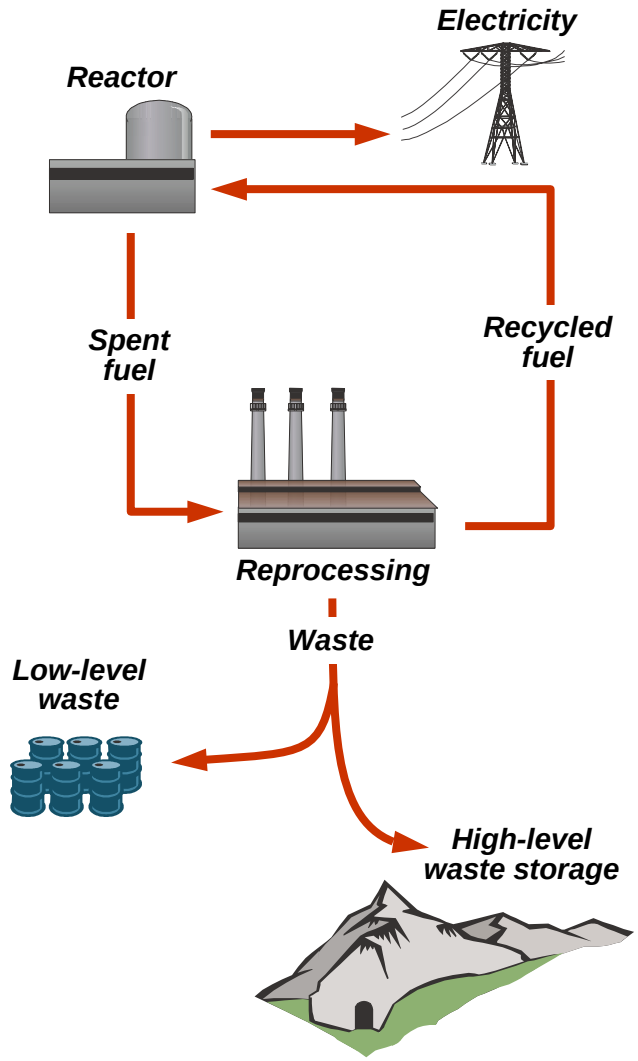
Radiotoxicity Reduction with Transmutation

Yucca Mountain Repository

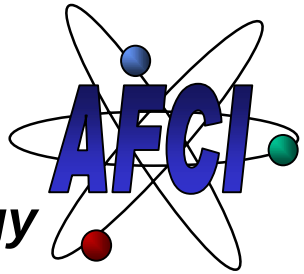


The Sustainable Fuel Cycle of the Future

- *Current U.S. "once-through" fuel cycle requires spent-fuel storage and management for thousands of years*
- *Lack of social/political acceptability of long-term waste storage may require a reexamination of U.S. waste management strategy*
- *Recycling of spent fuel reduces volume (96%) and lifetime (few hundred years) of disposable waste*
- *Advanced "fast" reactors can recycle multiple times*
  - *Burns plutonium and other long-lived materials*
  - *Extends fuel supplies 100X*
- *New recycle technology reduces nuclear materials proliferation-concern*



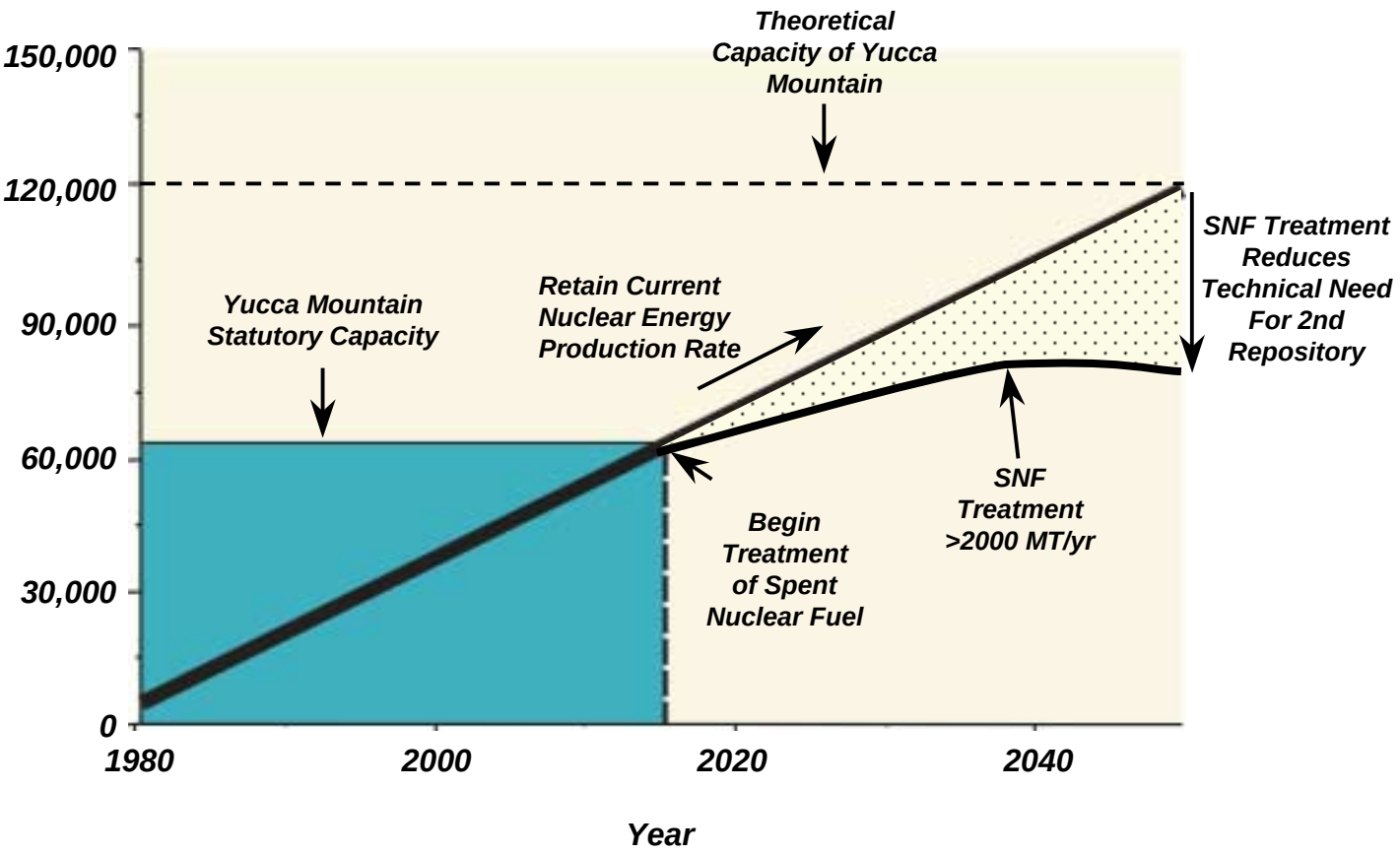
Advanced Fuel Cycle Initiative



The goal of the AFCI is to implement fuel cycle technology that:

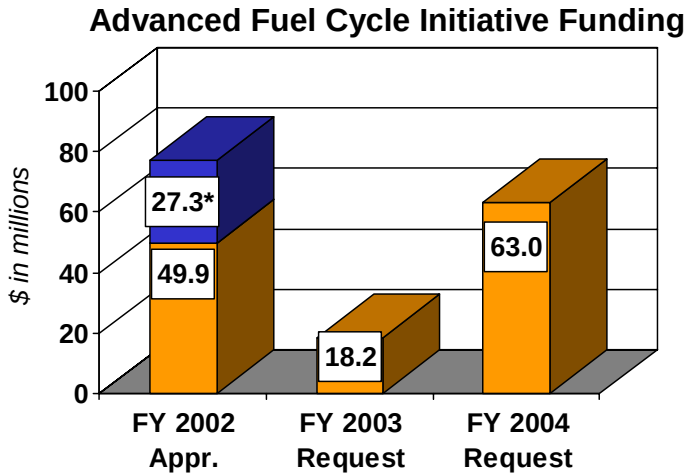
- ***Enables recovery of the energy value from commercial spent nuclear fuel,***
- ***Reduces the cost of geologic disposal of commercial spent nuclear fuel,***
- ***Reduces the inventories of civilian plutonium in the U.S.,***
- ***Reduces the toxicity of high-level nuclear waste bound for geologic disposal, and***
- ***Enables more effective use of the currently proposed geologic repository so that it will serve the needs of the U.S. for the foreseeable future.***

Benefit of Spent Nuclear Fuel Treatment



AFCI: Optimizing Spent Nuclear Fuel Disposition

- **Built on international cooperation and collaboration (e.g., France and Russia) and integrated with Generation IV**
- **Report to Congress on Advanced Fuel Cycle Initiative: The Future Path of Spent Fuel Treatment and Transmutation Research *issued (January 2003)***



**Activities related to deactivation of EBR-II.*

Planned Accomplishments -- FY 2004

- **Conduct research on proliferation-resistant fuel treatment technologies**
- **Develop technologies to reduce toxicity and heat load of fuel sent to a geologic repository**
- **Award additional 10 to 12 transmutation science fellowships to U.S. universities**

Nuclear Fuel Cycle Summary

- ***Expansion of nuclear energy will benefit energy security in both the electricity and transportation sectors of the U.S.***
- ***Nuclear waste management will need to address expanding needs***
- ***The DOE AFCI addresses transmutation with:***
  - ***Technology advances to utilize the LWR/ALWR fleet***
  - ***Technology advances to deploy with advanced fast reactors***
- ***The DOE Generation IV program addresses next-generation nuclear energy systems for hydrogen, waste management and electricity***
- ***These are long-term programs: many alternatives and options need to be explored***